Assessment of physical activity in the health care setting

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Introduction

In health care, the quality shall be continuously secured and developed. Follow-up of life-style habits such as physical activity does not differ from monitoring of other treatment in the health care setting. For systematic evaluation, valid and reliable methods are required as well as that measurements are conducted before and after interventions. In this paper, the concept of assessment is consistently used instead of measurement since certain measurements are direct while others are indirect and are based on the participant's own assumptions (1;2).

Physical activity is another word for body movement that results in increased energy expenditure. Accordingly, physical activity can be assessed in the form of energy expenditure or as behaviour. The components of aerobic physical activity that have shown a strong link with health are intensity, duration and frequency. For health-enhancing effects, the activity is recommended by WHO to be carried out at an intensity that is moderate, for a time (duration) of at least 150 minutes every week (preferable 3-5 days per week, frequency) or at an intensity that is vigorous, for a time of at least 75 minutes every week (3). A few different methods are described below that can be used to assess various aspects of physical activity.

Physical activity assessment methods

Questionnaires

Questionnaires for assessment of physical activity are the most common method and there are currently hundreds of versions available (2;4;5). The most basic questionaires only ask about the individual's exercise habits and offer pre-determined responses on a 3–5 degree scale. The more advanced questionnaires ask exactly what has been done and for the duration, and maybe even how often the individual has been physically active during a certain period of time (the past week, month, or a year).

Most questionnaires ask about the degree of exertion, which is affected by the individual's capacity. It is likely that the better aerobic fitness and strength the individual has, the easier the activity is perceived to be. In addition, the individual's body weight is of significance since it costs more energy to carry around more weight and the activity is then perceived as more strenuous. If exercise or training habits are asked about, it should be noted that the respondent only assesses parts of the total physical activity completed. These questions most often show a high degree of reliability and validity, since it is easier to remember what is done regularly and with a higher intensity (6;7). Exercise has also shown the strongest association to achieved health effects. However, if everyday activities are prescribed, they cannot be assessed with questions about exercise.

To calculate the energy expenditure from questionnaires, the given activities are weighted with an energy expenditure measure for the activity. Metabolic equivalent (MET), or a multiple of the oxygen uptake at rest, is often used (8). Resting corresponds to 1 MET and light activities 1–3 MET. Activities of moderate intensity can vary between 3–6 MET and activities that entail a high level of exertion are over 6 MET.

As many studies show, it has often been difficult to compare physical activity levels between countries since different methods have been used. This has led a group of international researchers to develop a method that measures all health-enhancing activity, a meassure which is standardised and can be used internationally. The International Physical Activity Questionnaire (IPAQ) was developed and method-tested at the beginning of the 2000s (9). As a supplement, the Global Physical Activity Questionnaire (GPAQ) was developed (10). These are now a national and international standard in several countries and organisations (WHO, EU).

Questionnaires are associated with methodological biases, as it is often difficult to remember exertion and that many individuals may have a tendency to over-report physical activity levels. When selecting the questionnaire for the assessment of physical activity can be a checklist used to assess the methodological quality and guidelines for the choice of method based on the issue, and how systematic method bias can be reduced (11;12).

Diaries

To determine the total energy expenditure and also obtain a measure of how the activity is divided over the day, diaries can be used (2;13). The diary should include what has been done based on given examples with a certain time interval (every 5th or 15th minute).

Diaries have shown a high degree of concordance with the total energy expenditure, but are time-consuming for the participants, which means that they are seldom useful in large scale studies or in clinical settings.

Movement sensors

To reduce the systematic errors that self-reports of physical activity entail (it is difficult to remember the degree of exertion, over-reporting is common, etc.), objective methods are recommended. The instruments that can assess activity directly are step-counters and accelerometers.

Pedometers provide a rough measure of the activity and their use can be beneficial in interventions so the persons themselves can follow their activity development since direct feedback to the individual is possible. It should be noted that there are many different brands of varying quality. Depending on sensitivity and so on, the variation in the number of steps can be more than 20 percent. A good pedometer should be method-tested in terms of reliability and validity, have a cap, not have a filter function and should be robust. The sensitivity should be 0.35 G, which means that it is sensitive to natural human movement (14). The disadvantage of pedometers primarily lies in the fact that they say nothing about intensity. This means that if a person walks 100 meters, the pedometer will register approximately 110 steps, while it only registers approximately 70 steps if the person runs.

Accelerometers are more advanced instruments. They measure acceleration in one, two or three orthogonal planes with the help of either a mechanical pendulum or a digital function. Acceleration is a direct measurement of body movement and the higher the acceleration, the greater the intensity. Besides total physical activity, accelerometers can also provide a measure of intensity, duration and frequency, and thus give a picture of the pattern of the activity. Another strength of the accelerometer is the ability to assess inactivity and sedentary behaviour. Most accelerometers also contain an inclinometer so body posture can be detected. Accelerometers are more costly than step-counters, but they are preferable if greater precision is desired. A good accelerometer should be method tested and easy to wear (15-17).

With accelerometer technology, a time period can also be set over which the activity should be summarised (a so-called epoch). The shorter the time period, the more precision is possible. For adults, the time period of one minute is most often used and for children 10–15 seconds. In addition, newer models of accelerometers manage to store data for a longer time, which means that measurements can be carried out for months if desired, but the individual's activity is usually measured for a week. Accordingly, an accelerometer produces enormous amounts of data. If a 15 second time period epoch is used, there will be four points per minute, times 1,440 minutes per day, times seven days per week, resulting in approximately 40,000 data points per individual. An extensive post-treatment of collected raw data is needed before a comprehensible description of an individual's physical activity can be made. In recent years pattern recognition using the accelerometer raw data has started to become a common way to analyze the data. This way is so far not user friendly, and few studies have shown a connection between this way of analyzing data and health outcomes.

An accelerometer can be worn on the hip, thigh, ankle or wrist. The position of the body affects the measurement because the movement pattern is perceived differently depending on where it is placed. The most common location is on an elastic band around the waist, near the center of the gravity. For this placement

most studies have demonstrated high validity for measuring the total energy expenditure. To placeme the accelerometer on the wrist as a watch is becoming more common,as it is perceived easier to carry, which will increase the likelihood of a person wearing the monitor. Placement of the accelerometer on the wrist can also catch arm movements that are not captured when the monitor is worn around the waist, which can also give an idea of the activities carried out solely by the arms or arm movements combined with body movements. Because of the risk of an overestimation of the total activity, placement of the accelerometer on the wrist lowers the validity. Another common location is on the thigh and is used primarily to assess the positions of seated and standing. The accelerometers commonly used in research and clinical practice are Actigraph, ActivPAL, Actiwatch, GENEActiv, RT3 and Actical. Since the principle of measuring the acceleration is the same for all products determines the appropriate price, how user-friendly the monitor and software as well as the issue that precedes the measurement.

The advantage of using accelerometers often outweighs the disadvantages, however. Both pedometers and accelerometers are insensitive to activities that take place with the upper-body or activities such as swimming and cycling. In spite of this, they provide a good view of overall activity and for accelerometers also of how the activity is divided over the day. Studies have shown that approximately 90 % of people's time awake is spent sedentary or by walking, which justifies the use of accelerometers as a measure of physical activity.

Heart rate monitoring

One way of indirectly measuring physical activity is to use heart rate monitors. With the help of a sensor around the chest and a receiver, the pulse can be continuously monitored. The pulse has a virtually linear relationship to exercise intensity (primarily aerobic work – with oxygen). Several models of heart rate monitors have the possibility of storing data and can be connected to a computer for processing. This method makes it possible to measure intensity, duration and frequency. It also provides a good measurement of the total energy expenditure (18). Heart rate monitors are frequently used at the individual level to find the individual's optimal exercise intensity based on current aerobic capacity.

Combination of methods

New instruments are constantly being developed to assess physical activity. The most modern instruments, which are more advanced and expensive than the aforementioned, combine several methods and technologies. Sensewear is worn on the upper arm and is an instrument that combines triaxial accelerometry with body temperature, heat flux and galvanic skin response. It gives a measure of the total energy and time spend in different intensities and the software is relatively easy to handle. ActiReg is an instrument that combines body position and movement separately or in combination with heart rate. ActiReg classifies the activity's energy expenditure in the categories easy, moderate or very strenuous. ActiHeart is another instrument that combines accelerometry and heart rate. In this method, the accelerometry weighs the heaviest at low intensity, while heart rate weighs heavier at high intensity. This way, the measurements are weighted to make the calculation of the completed physical activity more precise. New products combine accelerometry and GPS data (Global Positioning System) to also weigh in movements/distance in the calculations.

Assessment of sedentary behaviour

A person, who follows the health-enhancing recommendations, or the recommendations for strength and aerobic fitness, can also be sedentary for a significant part of the day. In other words, it is possible to periodically both be highly active and sedentary "at the same time" (19). Physical inactivity (can be defined as not fulfilling the recommendation) and being sedentary can thereby be viewed as two risk factors, which both need to be studied together and independent of one another.

To assess the degree of sedentary behaviour, different types of questions have been used, such as the time spent in front of the TV or computer. These questions are often misleading unless the total sedentary time and activity is also taken into account. Of the objective instruments, accelerometers and heart rate monitoring can provide an illustration of all so-called sedentary time, as well as active time. Pedometers however, cannot say anything about time spent sitting still. Questionnaires like the IPAQ can also provide an illustration of this behaviour.

Valid and reliable methods are needed for assessing whether an individual is sufficiently physically active, i.e. if her or he needs prescribed physical activity. It also requires that these are sensitive enough to detect a change in behavior (12). For example, the Swedish National Board for Health and Social Welfare has devel-

oped guidelines how health care should work with disease prevention methods have produced a number of measures of lifestyle, including physical activity (20). The measurements should be used as a basis for outcome and process indicators. Specific questions may also be used as an aid in the context of counselling with individuals about lifestyle habits, in order to identify individuals who are most in need of increasing their physical activity (an in-depth assessment may be required) and for monitoring changes in physical activity levels, both at individual and group level.

Assessment of physical activity within health care setting

For physical activity, the Swedish National Board for Health and Social Welfare has chosen two specific questions, one about physical exercise (high intensity) and one for everyday physical activity (moderate intensity). The questions are asking about total time of physical exercise and every day physical activity for a usual week (Figure 1).

Figure 1 Example of questions developed by the Swedish National Board for Health and Social Welfare, to assess and evaluate health-enhancing physical activity within the health-care setting.

1. How much time do you spend a usual week on **physical exercise** that makes you short of breath, such as running, aerobics and ball game?

☐ 0 minutes/not at all
☐ Less than 30 minutes
☐ 30-60 minutes (0,5-1 hour)
☐ 60-90 minutes (1-1,5 hour)
☐ 90-150 minutes (1,5-2,5 hours)
☐ 150-300 minutes (2,5-5 hours)
☐ More than 300 minutes (5 hours)

2. How much time do you spend a usual week on **every day activities**, such as walking, cycling or gardening? - Include all minutes but only those with at least 10 minutes per time.

☐ 0 minutes/not at all
☐ Less than 30 minutes
☐ 30-60 minutes (0,5-1 hour)
☐ 60-90 minutes (1-1,5 hour)
☐ 90-150 minutes (1,5-2,5 hours)
☐ 150-300 minutes (2,5-5 hours)
☐ More than 300 minutes (5 hours)

The questions are designed so that they can also capture incremental improvements even among those who are least active, regardless of whether they achieve the recommended level of activity or not. That question can capture changes of the least active is important, because these people have the most to gain by increasing their level of activity. In addition, it is important to keep in mind that you do additional health benefits if you have a level of activity that exceeds the recommended.

The results from question 1 (high intensity) and 2 (moderate intensity) of physical activity are weighted together to a common measure named activity minutes. The level of activity is adjusted to the intensity of the activity. Activities with a high intensity (question 1) is multiplied by a factor 2, while activity of less intensity (question 2) has a factor 1. I. e. 45 minutes of walking (45x1) plus 45 minutes of running (45x2 = 90 activity minutes) sums up to 135 activity minutes. The goal is to reach up to 150 activity minutes per week, which corresponds to the recommendation on physical activity. The questions are tested regarding reliability and validity, and show that they are equivalent with other self-reported questions about physical activity (21).

The use of objective measures of physical activity, such as accelerometry, within the health care setting is becoming more and more feasible and user friendly and is strongly recommended to reduce measurement errors due to recall bias.

Conclusion

This paper summarizes different methods for assessing physical activity. Valid and reliable physical activity measures are needed. Objective measures such as accelerometry are promising. The measures can assist health care workers in prescribing the right dose of physical activity and the measures are imperative when evaluating physical activity interventions in the health care setting.

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